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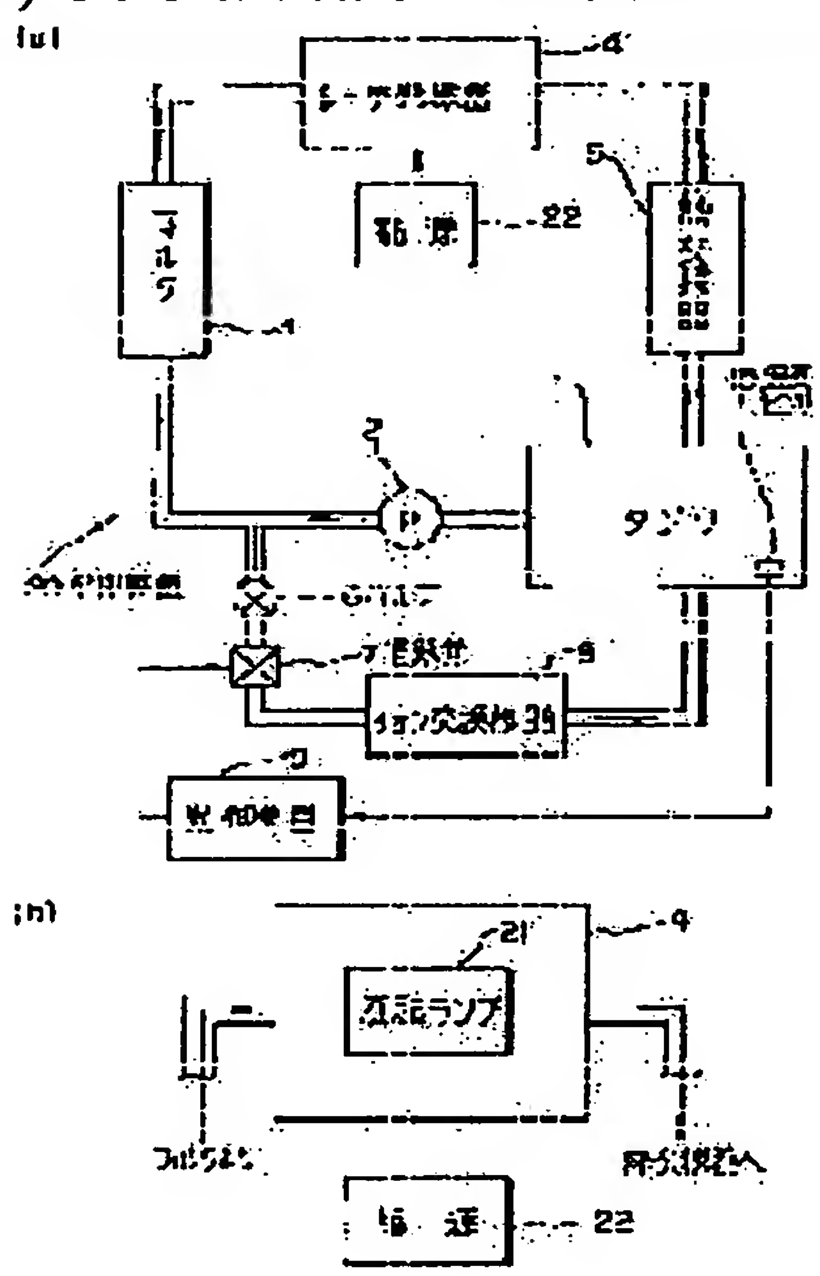
(54) COOLER FOR LASER DEVICE



(57)Abstract:
PURPOSE: To provide stable laser outputs while keeping the lighting property of an excitation lamp good by securing sufficient cooling power.
CONSTITUTION: Part of cooling water retained in a tank 1 is forced to circulate through ion exchange resin 8. The remaining amount of flow circulated by a pump 2 is fed to the excitation lamp 21 of a laser generator 4 and then the cooling water heated is cooled via a heat exchanger 5. When the temperature detected by a temperature sensor 10 provided inside the tank 1 is at or greater than a predetermined value a control unit 9 closes a solenoid valve 7 thereby reducing the amount of cooling water flowing through the ion exchange resin 8; i.e., the amount of flow of cooling water fed to the excitation lamp 21 of the laser generator 4 is increased to enhance cooling efficiency so as to restrain the temperature rise of the lamp.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the cooling system of the laser device which cools the heating source of a laser oscillator.
[0002]
[Description of the Prior Art]The laser device which irradiates with a laser beam oscillates a laser beam with a laser oscillator. As for the laser oscillator of this laser device, that excitation lamp generates heat during laser radiation. Therefore, in said laser

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device, cooling is needed in an excitation lamp and the water for cooling is circulated.
[0003]In the type which has an electrode of said excitation lamp in cooling water, if the electric resistance value of cooling water is low when making this excitation lamp turn on, current will flow not in inter-electrode but in cooling water, and it will become difficult to turn on the lamp. Then, using pure water as cooling water, by letting this pure water pass on ion-exchange resin, an electric resistance value is raised further, that is, insulation is improved, and lighting nature of the excitation lamp is improved.
[0004]However, pressure loss is too large when ion-exchange resin is provided between the pump for circulating the pure water for cooling, and said laser oscillator. That is, on the whole, circulation efficiency will worsen. For this reason, by dividing into two, on the other hand (most), it lets ion-exchange resin pass for a laser oscillator and another side, and the cooling water which comes out of said pump is carried out as [make / it / return to the tank in front of a pump]. Thus, since it is, the capability of a pump will not be full of the flow of the pure water which goes to said laser oscillator, some pure water for this cooling will be turned to the direction of ion-exchange resin, and refrigeration capacity will have been dropped as a whole.
[0005]
[Problem(s) to be Solved by the Invention]For the **** crack ****** reason, in conventional technology, the flow of cooling water was not necessarily able to say the part with the ability of efficient cooling to have been performed to ion-exchange resin.
[0006]Since the water temperature of cooling water will rise and the temperature of an excitation lamp will also rise if refrigeration capacity is inferior, a laser output will decline.
[0007]This invention was made in view of said situation, and an object of this invention is to provide the cooling system of the laser device which can secure sufficient refrigeration capacity and can obtain the stable laser output.
[0008]
[Means for Solving the Problem]This invention is provided with the following.
Inside of a flow circulated by a circulating drive means by cooling water stored by tank, Ion in said cooling water is removed for the part through an ion exchange means, In a cooling system of a laser device which cools via a heat exchange means and returns again said cooling water warmed by said heating source to said tank after sending the remaining flows to a heating source of a laser oscillation means, while returning to said tank again, A temperature detecting means which detects either [at least] temperature of said cooling water, or temperature of a heating source of a laser oscillation means.
A flow control means which adjusts a flow of said cooling water which flows through said ion exchange means.
A control means which controls flow control by said flow control means based on temperature which said temperature detecting means detected.

[0009]
[work --] for This invention controls a flow control means by a control means based on temperature which a temperature detecting means detected, and adjusts a flow of cooling water which flows into an ion exchange means. A flow of cooling water which flows into a heating source of a laser oscillation means is also adjusted with this adjustment.
[0010]

[Example]With reference to figures, the example of this invention is described below. Drawing 1 is a lineblock diagram of the cooling system of the laser device concerning one example of this invention.
[0011]The cooling system 20 of the laser device shown in drawing 1 (a) is for suppressing generation of heat of the excitation lamp 21 used as the heating source shown in drawing 1 (b), and maintaining the lighting nature of the lamp 21 good.
[0012]Drawing 3 (c) is the probe 31 for laser which constitutes said laser device. This probe 31 for laser has the fiber 32 to which the laser beam which the laser oscillator mentioned later emits is led, and it irradiates with the light which the fiber 32 drew from the tip part 33a of the handpiece 33.
[0013]As shown in drawing 3 (d) which is an A-A line sectional view of drawing 3 (c), the three switches 34 which turn on and off outgoing radiation of laser on the periphery are formed in the body part 33b of the handpiece 33. The three switches 34 are mostly arranged at intervals of division into equal parts in said periphery. The three switches 34 are electrically connected in parallel. Therefore, a switch will be set to ON if any one is pushed.
[0014]Including said three switches 34, a part of the periphery is resin or metal, and the body part 33b of the handpiece 33 is covered with the covering 35 which has elastic force in an outer peripheral direction. The covering 35 is covered with the rubber cover 36.
[0015]Drawing 2 (a) and (b) shows the laser probe 41 used from the former. This laser probe 41 has formed the switch 42 which turns on and off outgoing radiation of laser with a finger in the handpiece 43. In drawing 2 (a), it is the contact type chip 44 which a dashed dotted line shows. This contact type chip 44 can be freely detached and attached to the handpiece tip part 43a.
It is a thing of the mold which an exposure object is made to contact and is made to irradiate with a laser beam.

[0016]In composition of being shown in drawing 2, said switch 42 was one place, in order to operate the switch 42, the grip position of the handpiece 43 needed to be checked one by one, and a switch might be unable to be pushed in case of emergency. As especially shown in drawing 2 (b), since it could not grasp in the position which the switch 42 tends to push depending on condition of use, there was a case where it was hard to use, by the thing of the type at which the tip part 45 of the handpiece turned.
[0017]On the other hand, the probe 31 shown in drawing 3 forms two or more switches 34, covers it by the covering 35, and is carrying out holding fixing by the rubber cover 36 further for water proof. If it grasps by this so that the covering 35 may be contracted even if it grasps the handpiece 33 from which direction, the switch 34 will be turned on and a laser beam will be emitted. On the other hand, if the power to grasp is weakened, in the covering 35, the shape returns according to elastic force at an outer peripheral direction, the switch 34 will serve as OFF and outgoing radiation of a laser beam will suspend it.
[0018]Thus, since it is easy to push and easy to use the probe 33 shown in drawing 3, laser outgoing radiation can make it turn on and off easily if needed, without caring about a gripping position.
[0019]Next, the composition of said cooling system 20 shown in drawing 1 is explained.
[0020]Said cooling system 20 is a type which has an electrode of said excitation lamp 21 in cooling water. This cooling system 20 circulates the pure water for cooling so that it

may pass along the lamp 21.
It is constituted so that some pure water may be poured also on the ion-exchange resin later mentioned for on the other hand keeping the electrical resistance of the pure water to be used high.

[0021]Said cooling system 20 has the tank 1 which stores the pure water as cooling water. As one circulation system of the cooling system 20, free passage connection of said tank 1, the pump 2 as a circulating drive means, the filter 3, the laser oscillator 4 as a laser oscillation means, and the heat exchanger 5 as a heat exchange means is made with a pipeline, respectively, Furthermore, free passage connection is made and the heat exchanger 5 is constituted by the tank 1. The cooling water of said tank 1 is sent to the laser oscillator 4 via the filter 3 with the pump 2 which is a driving source of this hydrologic cycle. Said filter 3 sticks to the impurity in cooling water, for example, garbage etc., and is removed from cooling water.
[0022]As shown in drawing 1 (b), said laser oscillator 4 constitutes a laser device, and contains the excitation lamp 21. Said excitation lamp 21 has connected the power supply 22 provided in the exterior of the laser oscillator 4.
Excitation light is published.
The laser medium which was excited by said excitation light and which is not illustrated, for example, a YAG rod, oscillates a laser beam.
[0023]The pure water sent to said laser oscillator 4 passes along the circumference of said excitation lamp 21, is sent to the heat exchanger 5, and flows back on the tank 1 again.
[0024]As for the pipeline which connects the pump 2 and the filter 3, the halfway has branched.
It is connected to the valve 6 and the end of branching is open for free passage.
Said valve 6 is opened for free passage and connected via the electromagnetic valve 7 and the ion-exchange resin 8 in order to said tank 1. That is, the circulation system of another side from which some cooling water returns to the tank 1 through the ion-exchange resin 6 also has said cooling system 20.
[0025]Said valve 6 is for setting up beforehand the rate of the quantity of the pure water which goes to the ion-exchange resin 8 as an ion exchange means. The electromagnetic valve 7 as a flow control means established between said valve 6 and the ion-exchange resin 8 is electrically controlled by the control device 9 as a control means. This control device 9 receives the temperature signal which the thermo sensor 10 formed in the tank 1 detected, and controls opening and closing of said electromagnetic valve 7.
[0026]If the electric resistance value of cooling water is low when making said excitation lamp 21 turn on, current will flow not in inter-electrode but in cooling water, and it will become difficult to turn on the lamp 21. Then, using pure water as cooling water, by letting this pure water pass on the ion-exchange resin 8 further, an electric resistance value is raised further and lighting nature of the excitation lamp is improved.
[0027]Pressure loss is too large when the ion-exchange resin 8 is formed between the pump 2 for circulating the pure water for cooling, and said laser oscillator 4, as already stated. For this reason, the cooling water which comes out of said pump is constituted from this example so that one side may be returned to the laser oscillator 4 and the tank which passes along the ion-exchange resin 5 and is in front of the pump 2 about another side one time by dividing into two.

[0028]With said composition, an impurity is removed through the filter 3 and the cooling water of the tank 1 attracted by the pump 2 is sent to the laser oscillator 4. Said cooling water absorbs the heat of the excitation lamp 21 of the laser oscillator 4. Thereby, the water for said cooling will be warmed and this warmed water flows into the heat exchanger 5 further. In the heat exchanger 5, by spraying external air, heat exchange is performed and the temperature of the water which flowed is lowered. The pure water again cooled by the heat exchanger 5 returns to the tank 1 after that, passes along the ion-exchange resin 8 from the pump 2, and is the other side to the laser oscillator 4 again. Thus, as long as the pump 2 drives if needed, circulation for cooling said excitation lamp 21 is performed repeatedly.
[0029]Some pure water which came out of the pump 2 is sent to the ion-exchange resin 7 at a decided rate by the valve 6 to which the flow was set beforehand. In the ion-exchange resin 7, the resistance in pure water is highly maintained by ionic exchange. The pure water which passed through the ion-exchange resin 7 returns to said tank 1 again. The thermo sensor 10 included in the tank 1 detects the temperature of the pure water in the tank 1, and transmits to the control device 9.
[0030]Said control device 9 controls opening and closing of the electromagnetic valve 7 based on the temperature which the thermo sensor 10 detected. That is, if temperature is the temperature which does not cause the fall of a laser output, the electromagnetic valve 7 will be considered as as [open], and if it becomes the temperature to which a laser output falls, let the electromagnetic valve 7 be close. For example, seaside water temperature in case the laser output of said excitation lamp 21 declines shall be about 45 **. And let this water temperature be the preset temperature in control device 9 inside which carries out opening and closing control of the electromagnetic valve 7. Here, since it circulates through said cooling water and has the water temperature of cooling water, the temperature of the excitation lamp 21, and high correlation, it is detectable that a laser output declines by water temperature detection.
[0031]Therefore, laser is oscillated from the laser oscillator 4, and when the temperature of the pure water for cooling rises gradually and becomes not less than 45 **, the control device 9 is controlled to close said electromagnetic valve 7.
[0032]The temperature of the excitation lamp 21 is detected directly and it may be made to control opening and closing of the electromagnetic valve 7. Or it may be made to detect the water temperature in said laser oscillator 4.
[0033]By making said electromagnetic valve 7 close, the flow to the ion-exchange resin 8 is cut, and cooling water flows through it into the part and laser oscillator 4 side mostly. That is, in this example, it is possible to pour pure water by a capabilityful of a flow of the pump 2 to the laser oscillator 4. With close [of the electromagnetic valve 7], the flow per unit time which it lets pass around the excitation lamp 21 can be made at least more than it or before. Therefore, before the calorific value of the excitation lamp 21 becomes large and a laser output declines, cooling efficiency is raised with this example and the lighting nature of an excitation lamp can be maintained good by it. And the stable laser output can be obtained in this example.
[0034]By the way, once it switches on the light, said excitation lamp 21 will not go out easily, even if the electric resistance value of pure water falls. Therefore, at the time of a rise in heat, even if it stops the inflow of the pure water to the ion-exchange resin 8 (to a flow and zero), it is satisfactory.

[0035]As mentioned above, the stable laser output can be obtained in this example, keeping the lighting nature of an excitation lamp good.

[0036]

[Effect of the Invention]According to the cooling system of the laser device of this invention, sufficient refrigeration capacity over the light source of a laser oscillation means can be secured, and it is effective in the ability to make the stable laser output obtained.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]Drawing 1 is a lineblock diagram of the cooling system of the laser device concerning one example of this invention.

[Drawing 2]Drawing 2 (a) and (b) is a perspective view of the laser probe used from the former.

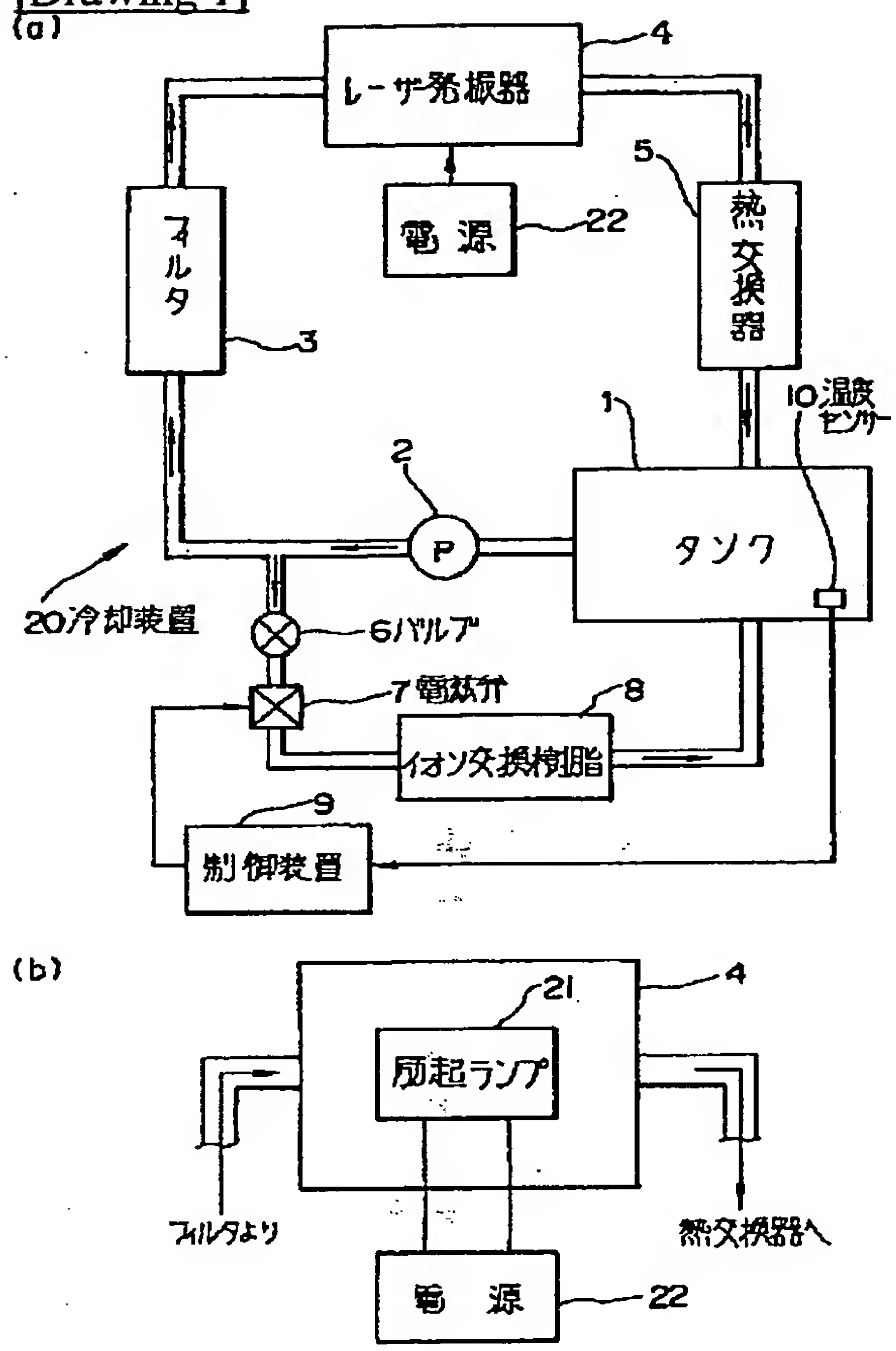
[Drawing 3]The perspective view of drawing 3 (a) and a ** laser probe. Drawing 3 (b) is an A-A line sectional view of a figure (a).

[Description of Notations]

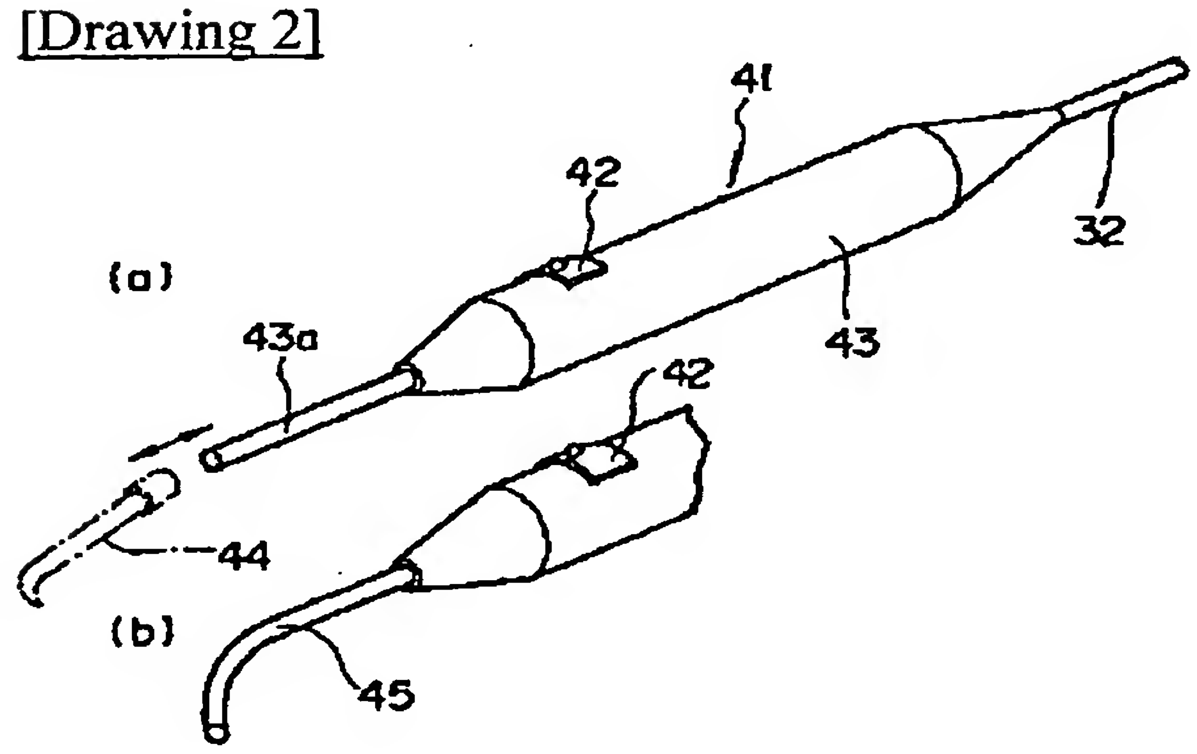
20 -- Cooling system
1 -- Tank
2 -- Pump
3 -- Filter
4 -- Laser oscillator
5 -- Heat exchanger
6 -- Valve
7 -- Electromagnetic valve
8 -- Ion exchange equipment
9 -- Control device
21 -- Excitation lamp
22 -- Power supply

DRAWINGS

[Drawing 1]



[Drawing 2]



[Drawing 3]

(c)

(d)